

# Investigation of Guidance Technologies for Spinning Projectiles

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**36th Annual Gun & Ammunition  
Symposium & Exhibition  
San Diego, CA**

**April 9-12, 2001**









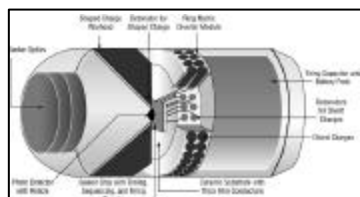
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# OUTLINE

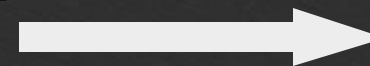
- Discussion of Guidance Approach
- Applications
- Accuracy and Effectiveness Benefits
- Summary

# Evolution of Guided Projectiles

Conventional Munitions	Guided Munitions		LOW COST COURSE CORRECTION
<p>1960's - 1970's</p> <p>Cost &lt; \$1,000 </p> <p>Volume 100,000</p>	<p>1980's</p> <p>Cost \$30,000 </p> <p>COPPERHEAD </p> <p>SADARM </p> <p>Gimbaled Seeker Laser Designator</p>	<p>1990's</p> <p>Volume 5,000</p> <p>PGMM </p> <p>XM982 </p> <p>ERGM </p> <p>Laser Designator Gimbaled Seekers Sensor-Fuzed Munitions Radar Receivers GPS Growth to IR/Fire &amp; Forget</p>	<p>New Millenium</p> <p>Cost &lt; \$1,000 </p> <p>Volume 100,000</p> <p></p> <p>Explosive thrusters Laser receivers Automated manufacturing</p> <p>Applications 25mm Bullet KE Applications 2.75 Rockets 60/81mm Mortars 105mm Artillery Shoulder Fixed Systems Tank Ammunition</p>



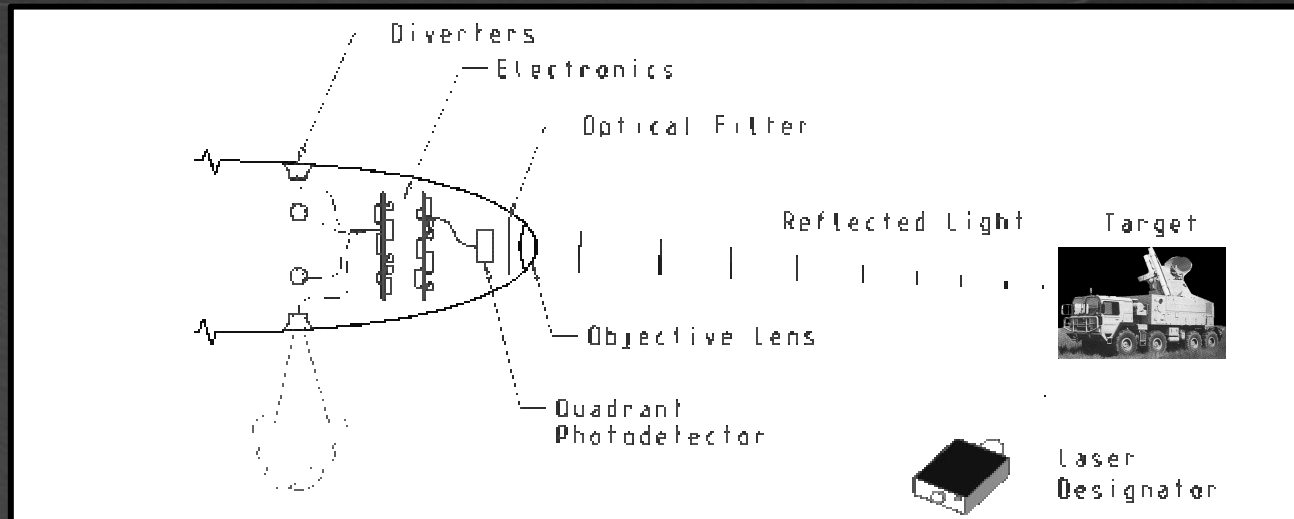
**BACK TO THE FUTURE**



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# Guidance Approach for Spinning Projectiles



- **Approach**

- Improve CEP of Rockets and Bullets using Body Fixed Guidance Approach
- Employ Control System after build up of angular error exceeds threshold
- Fast impulse thrusters for control authority
- Low cost seeker using using off the shelf components

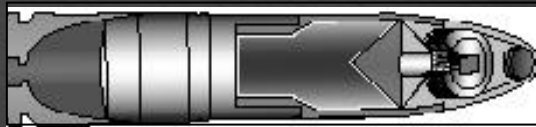
# Applications



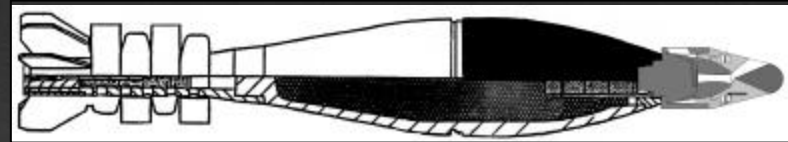
2.75" ROCKET



Tank Ammunition



Medium Caliber Projectiles



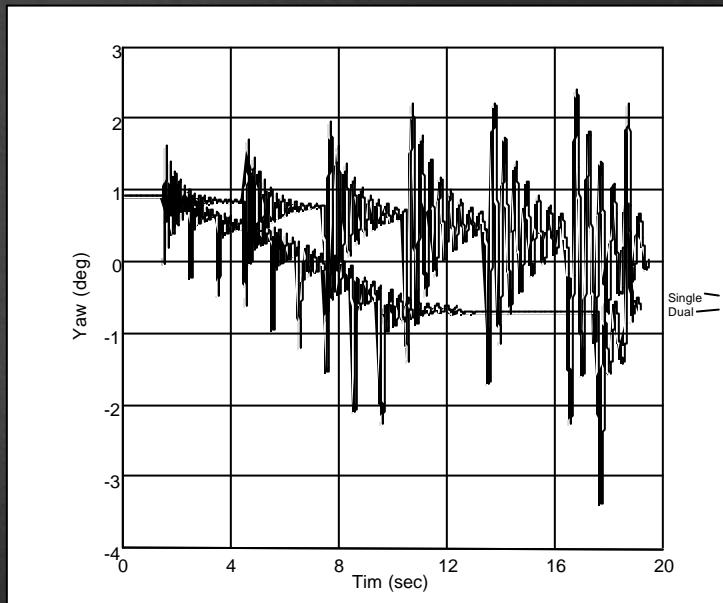
Mortars

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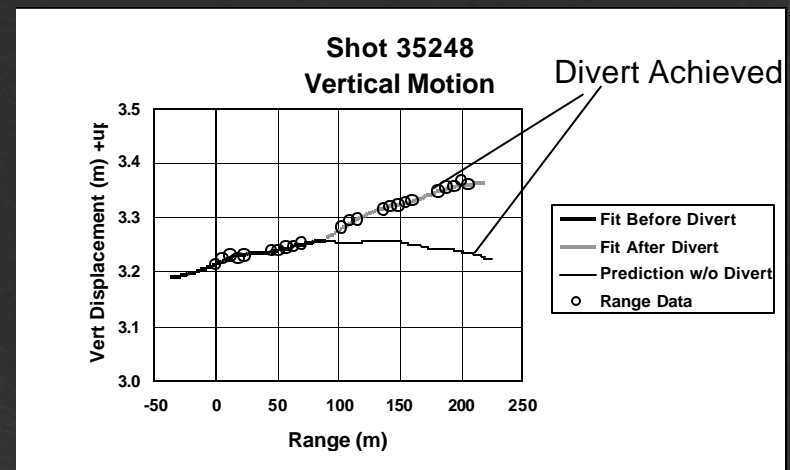
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# Energetic Diverter Development

## Aerodynamic Modeling



## Flight Testing

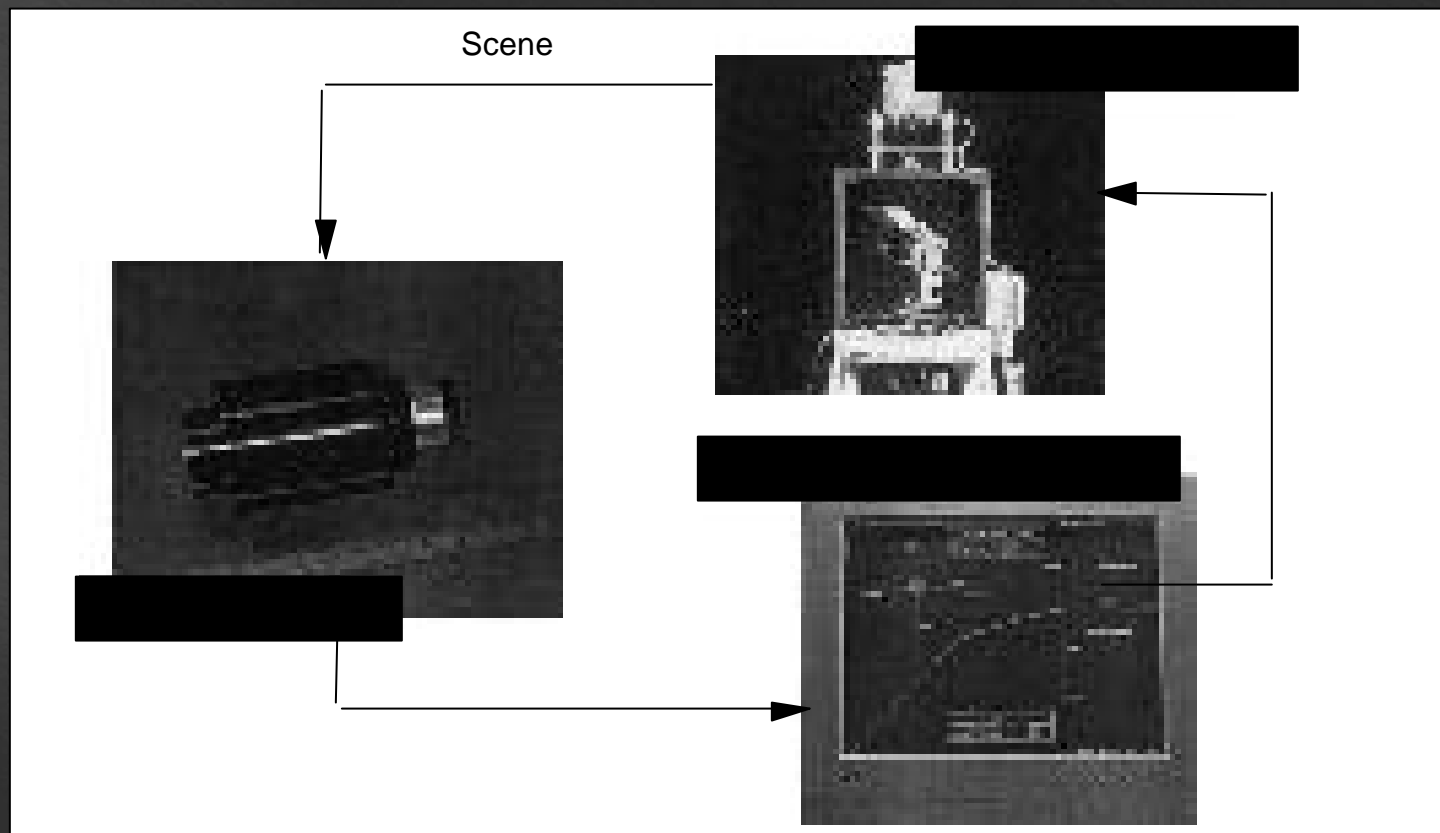


- Modeling shows feasibility of using thrusters to improve accuracy
- Flight Testing has shown amplification factor of diverters due to aerodynamic interaction

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# HARDWARE-IN-THE-LOOP SIMULATIONS



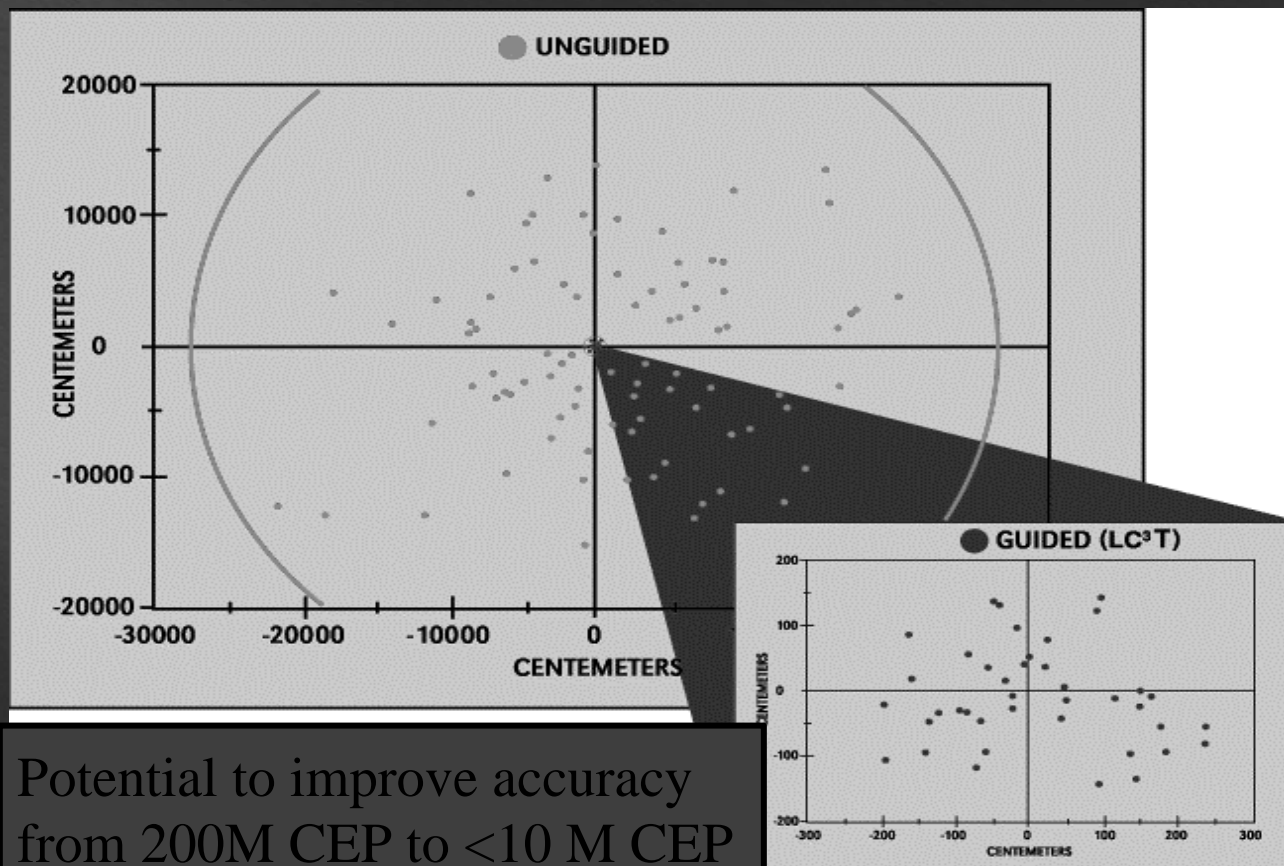
Conducting Hardware in the Loop Testing to Verify Seeker Function

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# ACCURACY IMPROVEMENT

## 2.75" Rocket 6DOF Modeling



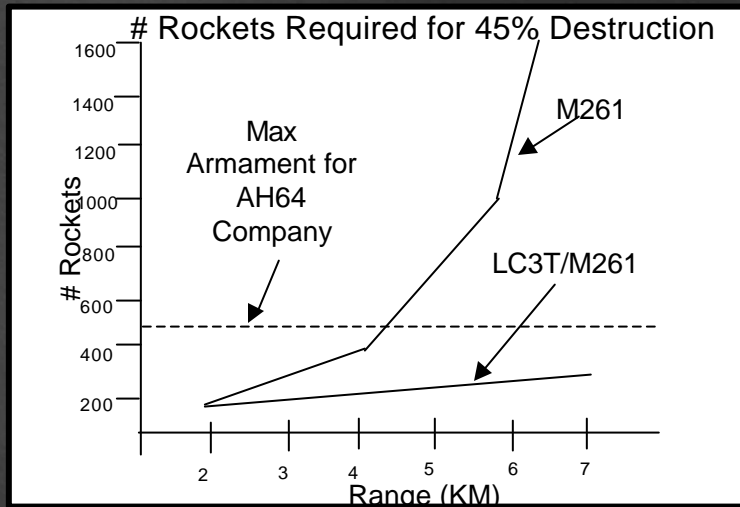
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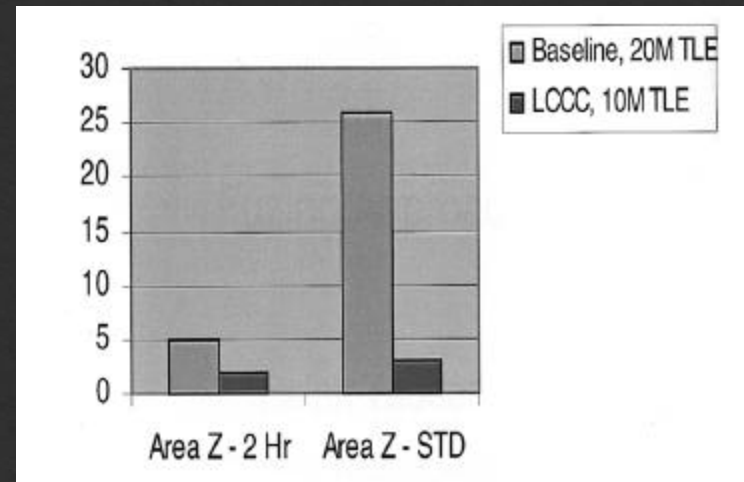
# Effectiveness Analysis

## 2.75" HYDRA-70 Rocket



- Target -Dismounted Motorized Infantry Company
- Significantly fewer rounds required to defeat target with more accurate rocket

## 120mm Mortar



- 60% fewer rounds required with LCCC for 2 hr MET
- 90% fewer rounds required with LCCC for STD MET

**Greatly improves logistics and survivability**

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# SUMMARY

- Affordable guidance key to future military effectiveness
- Significant Accuracy Improvement Appears Achievable with Body Fixed guidance approach employing fast impulse thrusters and low cost Seeker
- Applications to new and existing munitions and rockets
- Further work concentrating on demonstration testing and gun hardening of components